ANALYSIS OF P-TYPE CVD DIAMOND FOR HIGH-POWER AND HIGH-TEMPERATURE APPLICATIONS

Susan L. Heidger

Air Force Research Laboratory

AFRL/PRPE, 1950 Fifth St., Wright-Patterson AFB, OH 45433

(937) 255-6932, Fax: (937) 255-3211, Susan.Heidger@wpafb.af.mil

Jacob K. Matthews

UES, Inc.

4401 Dayton-Xenia Rd., Dayton, OH 45432

(937) 255-4132, Fax: (937) 255-3211, Jacob.Matthews@wpafb.af.mil

Howard E. Smith

University of Dayton Research Institute

300 College Park, Dayton, OH 45469

(937) 255-6366, Howard.Smith@wpafb.af.mil

Keywords: CVD diamond, high temperature, ohmic contacts, doping, passivation

Abstract

Conductive polycrystalline diamond films are desirable for a variety of high temperature and high power applications due to their high thermal conductivities, approaching the 20 W/cm-ºK of natural diamond. P-type diamond films may be produced by introducing boron as a dopant during growth by chemical vapor deposition (CVD). These films have properties which make them ideal for both passivation layers and ohmic contacts when a thin layer of p-type diamond is grown on top of non-conductive diamond. Applications in electronic devices that benefit from these films include passives, electromechanical devices, switches, integrated circuits, sensors and diamond heat spreaders [1].

Diamond films were produced in a 1.5 kW ASTEX system by Microwave Plasma Enhanced Chemical Vapor Deposition (MWCVD). Microwave power was 900 W and methane concentration in hydrogen was approximately 0.25%. Pressure was 25 mtorr and the substrate was heated to approximately 670 ºC. Boric acid dissolved in methanol was used as a dopant source and was delivered by bubbling hydrogen through a system of two bubblers in series. The head pressure of the bubblers was regulated at approximately 150 torr. The hydrogen flow rate was varied from 2.5 to 15 sccm to adjust the dopant concentration. Boron concentration was measured by Secondary Ion Mass Spectroscopy. Film thicknesses of approximately 15,000 Å were measured using a Dektak^{3}ST surface profiler. Film morphology was examined using scanning electron microscopy. Resistivity measurements were performed using the transmission line technique where the resistance is measured between two patterned contacts.

REFERENCES

1. Heidger, S.L., et al.: “High Power and High Temperature Applications for CVD Diamond,” *Proc. Int’l High Temp. Elect. Conf. (HiTEC)*, IMAPS, 18-20 May, pages (2004).